Claims

[c1] A ceramic film for reducing leakage of a selected gas through an outer surface of a porous ceramic substrate structure having an interior portion formed with the outer surface; the substrate being porous to at least one selected gas, the ceramic film comprising:

a first ceramic coating layer for adherence to at least a portion of the outer surface of the ceramic substrate structure; the first ceramic coating being initially applied in a suspension state, the first ceramic coating suspension having a desired level of viscosity for substantially uniform application to the surface; and being formed with a ceramic electrolyte powder and at least one organic additive; and

a second ceramic coating layer for adherence to at least a portion of the outer surface of the ceramic substrate structure following application of the first ceramic coating and subsequent to a drying process of the first ceramic coating; the second ceramic coating being initially applied subsequent to application of the first ceramic coating; the second ceramic coating being initially applied in a suspension state having a lower viscosity relative to the viscosity of the suspension used for the first coating.

[c2] The invention of claim [Claim Reference] further including a third ceramic coating layer adhered to at least a portion of the outer surface of the ceramic substrate structure following application of the second ceramic coating; the third ceramic coating being initially applied subsequent to applying the second ceramic coating; the third ceramic coating being initially applied as a suspension having a lower viscosity relative to the viscosity of the suspension for the second ceramic coating.

[c3] The invention of claim [Claim Reference] wherein a vacuum is applied to the ceramic substrate structure on a side directionally opposite to the first ceramic coating in relation to the outer surface; the vacuum is formed during the application of the ceramic coating to the ceramic substrate structure while the ceramic coating is in a suspension state.

[c4] The invention of claim [Claim Reference] wherein the first ceramic coating comprises toluene, ethanol, butyl benzyl phthalate, polyvinyl butyral, and a powder of $Ce_{0.8}Gd_{0.2}O_2$ (CGO).

[c5] The invention of claim [Claim Reference] wherein the ceramic coating layers are applied to the ceramic substrate by dipping a portion of the ceramic substrate into the desired suspension.

[c6] The invention of claim [Claim Reference] wherein the viscosity of the ceramic coating suspension is in the range of 50-200 cPs.

[c7] A method of manufacturing a ceramic film for reducing leakage of a selected gas through an outer surface of a porous ceramic substrate structure having an interior portion formed with the outer surface; the substrate being porous to at least one selected gas comprising:

applying a first ceramic coating layer to at least a portion of the outer surface of the ceramic substrate structure; the first ceramic coating being initially applied in a suspension state, the first ceramic coating suspension having a desired level of viscosity for substantially uniform application to the surface; and being formed with a ceramic electrolyte powder and at least one organic additive; and

applying a second ceramic coating layer to at least a portion of the outer surface of the ceramic substrate structure following application of the first ceramic coating and subsequent to a drying process of the first ceramic coating; the second ceramic coating being initially applied subsequent to application of the first ceramic coating; the second ceramic coating being initially applied in a suspension state having a lower viscosity relative to the viscosity of the suspension used for the first coating.

[c8] The method of claim [Claim Reference] further including applying a third ceramic coating layer to at least a portion of the outer surface of the ceramic substrate structure following application of the second ceramic coating; the third ceramic coating being initially applied subsequent to applying the second ceramic coating; the third ceramic coating being initially applied as a

suspension having a lower viscosity relative to the viscosity of the second ceramic coating.

[c9] The method of claim [Claim Reference] wherein a vacuum is applied to the ceramic substrate structure on a side directionally opposite to the first ceramic coating in relation to the outer surface; the vacuum is formed during the application of the ceramic coating to the ceramic substrate structure while the ceramic coating is in a suspension state.

[c10] The method of claim [Claim Reference] wherein the first ceramic coating comprises toluene, ethanol, butyl benzyl phthalate, polyvinyl butyral, and a powder of $Ce_{0.8}Gd_{0.2}O_2$ (CGO).

[c11] The method of claim [Claim Reference] wherein the ceramic coating layers are applied to the ceramic substrate by dipping a portion of the ceramic substrate into the desired suspension.

[c12] The method of claim [Claim Reference] wherein the viscosity of the ceramic coating suspension is in the range of 50-200 cPs.

[c13] A coated ceramic apparatus comprising:

a porous ceramic substrate structure having an interior portion formed with the outer surface; the substrate being porous to at least one selected gas;

a first ceramic coating layer for adherence to at least a portion of the outer surface of the ceramic substrate structure; the first ceramic coating being initially applied in a suspension state, the first ceramic coating suspension having a desired level of viscosity for substantially uniform application to the surface; and being formed with a ceramic electrolyte powder and at least one organic additive; and

a second ceramic coating layer for adherence to at least a portion of the outer surface of the ceramic substrate structure following application of the first ceramic coating and subsequent to a drying process for the first ceramic coating; the second ceramic coating being initially applied subsequent to application of the first ceramic coating; the second ceramic

coating being initially applied in a suspension state having a lower viscosity relative to the viscosity of the suspension used for the first coating;

whereby the ceramic coating layers substantially prevent leakage of the selected gas through the outer surface from the interior portion of the ceramic substrate structure.

[c14] The apparatus of claim [Claim Reference] further including a third additional ceramic coating layers adhered to at least a portion of the outer surface of the ceramic substrate structure following application of the second ceramic coating; the third additional ceramic coatings being initially applied subsequent to applying the second ceramic coating; the third additional ceramic coatings being initially applied as a suspension having a lower viscosity relative to the viscosity of the second ceramic coating.

[c15] The apparatus of claim [Claim Reference] wherein a vacuum is applied to the ceramic substrate structure on a side directionally opposite to the first ceramic coating in relation to the outer surface; the vacuum is formed during the application of the ceramic coating to the ceramic substrate structure while the ceramic coating is in a suspension state.

[c16] The apparatus of claim [Claim Reference] wherein the first ceramic coating comprises toluene, ethanol, butyl benzyl phthalate, polyvinyl butyral, and a powder of $Ce_{0.8}Gd_{0.2}O_2$ (CGO).

[c17] The apparatus of claim [Claim Reference] wherein the ceramic coating layers are applied to the ceramic substrate by dipping a portion of the ceramic substrate into the desired suspension.